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Reply to: 3420

December 19, 1989

F.S. R-6 Date
RECEIVED
DEC 26 1989
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Subject: Pest Damage to Kuhn Ridge Seed Orchard

To: District Ranger, Wallowa Valley Ranger District

On August 22, 1989, Don Scott (Zone Entomologist), Roger Sandquist (Forest Pest Management Entomologist), and Victoria Rockwell (Tree Improvement Specialist) visited the Wallowa Valley Ranger District at the request of Mike Straw.

The purpose of the visit was to evaluate grasshopper damage on the Kuhn Ridge Seed Orchard, and to make recommendations for managing grasshoppers to reduce populations and minimize future damage to the orchard. Subsequent to this visit, several other insects and insect damage to conifers in and around the seed orchard were noted by district personnel. This report will address the District concerns about other insects and damage, as well as the grasshopper problem at Kuhn Ridge Seed Orchard.

In addition, there is an overriding need to develop a pest management plan for the seed orchard to deal with future pest problems. The proposed development of such a plan is discussed.

An evaluation of pest occurrence and damage was done in a "walk-through" examination of the Kuhn Ridge Seed Orchard on August 22. Don, Roger, and Victoria were joined by Mike Straw and Gary Court for the examination.

Background/Seed Orchard Establishment

The Kuhn Ridge Seed Orchard was established between 1986 and 1989. The site is located within an old Douglas-fir tussock moth (Orgyia pseudotsugata) outbreak area in which approximately 200 acres were harvested by clearcut and shelterwood regeneration methods in the 1970's. Final overstory removal on Kuhn Ridge was done three years ago. An established plantation of ponderosa pine, lodgepole pine, and Douglas-fir was left around the approximately 50 acre seed orchard site. Additional western larch, lodgepole pine, and grand fir seeded in naturally within the area surrounding the seed orchard.

The plant association on most of the site is a grand fir/twinflower. The site is on a relatively gentle slope. Soils are represented by both ash and residual.

The site was prepared by removal of stumps, removal of rocks down to 8 inches, and cross-ripping to a depth of 18 inches with a winged-tooth ripper. Cross-ripping was not completely achieved to the desired depth

across the seed orchard, however, due to problems with the operator. The seed orchard still has a fair amount of soil compaction in places.

The seed orchard site was seeded with red fescue last year. Timothy and blue grasses are present as residuals from the old stand. Pinegrass and elk sedge were also present on the site.

The seed orchard was planted this spring with 2-0 Douglas-fir and ponderosa pine, and 1-1 western larch. Mortality of planted stock to date has been relatively low.

Pest Conditions

During the late spring and early summer of this year, district personnel began seeing insect feeding damage to the newly-planted Douglas-fir seedlings. The damage appeared to be associated with populations of grasshoppers. Eggs are laid throughout the fall and the hatch usually begins in May and goes through June. Hatches are usually spread out and correspond to whether eggs were laid early or late the previous fall.

Grasshopper and cricket specimens were collected at the seed orchard for lab identification by pest specialists. The following species were tentatively identified:

Migratory grasshopper, Melanoplus sanguinipes
Red-legged grasshopper, M. femurrubrum
and M. flavidus

In addition, the Mormon cricket, Anabrus simplex, was also present. Other grasshopper species may have been present also, but were not collected during a casual sampling of the insect population.

Damage from the grasshoppers was readily apparent, but did not appear to be serious. High populations of grasshoppers are capable of completely stripping the foliage from seedlings and destroying young plantations and seed orchards in one season.

Damage was mostly confined to the fresh flush of foliage on Douglas-fir. Early damage appeared as feeding gouges or mines along the underside of the needles; other needles were completely consumed to the stem. This latter damage was especially noticeable on certain groups of seedlings from one family.

Usually damage increases in severity by August, when grasshoppers feed voraciously in the later instars and as adults. At the time of our site visit in late August, grasshopper damage to the seed orchard had stabilized. An abundance of grasses, forbs, and herbaceous vegetation provided adequate food for grasshoppers on the seed orchard over the summer, preventing further damage to seedlings. Also, new foliage on newly-planted Douglas-fir seedlings may have become less palatable to the grasshoppers as the season progressed, and feeding by grasshoppers may have tapered off, accordingly.

In a previous early-season evaluation of grasshopper damage to the seed orchard, district personnel found grasshopper densities to range between 3-15 insects per square yard, and averaged around 7-8 per square yard. Animal and Plant Health Inspection Service (USDA-APHIS), and Oregon Department of Agriculture (ODA) considers a consistent count of eight or more third-instar or younger nymphs per square yard in rangeland or cropland, and 20 or more in margins, as an indication of possible need for control to reduce damage from adults.

Other pests on seedlings planted in the seed orchard or on trees within the young stand adjacent to the seed orchard appear to be minor. A bark adelgid on ponderosa pine (Pineus coloradensis), is a commonly found insect on newly-planted seedlings. The prolific production of a white flocculent waxy material which covers the adelgid body can sometimes be mistaken for a mold on seedlings, when adelgid populations are highly concentrated on stems, needles, or buds. Although populations can appear heavy at times, they fluctuate from year to year as well as during the season, and generally are not very damaging. Sometimes extremely severe infestations may cause needle yellowing and premature abscission. Damage may also include some growth loss, although this has never been quantified.

Another minor pest found on established ponderosa pine around the periphery of the orchard is a giant conifer aphid, Cinara ponderosae. This aphid feeds on the small branches and new shoots of young, open-grown trees. Aphid colonies are often large and dense, and tended by ants for the honeydew they produce.

Heavy infestations can cause yellowing of foliage and reduce tree growth, especially on young trees. During droughty years, heavy infestations of root or rootcrown feeding aphids can kill small trees. Damage caused by feeding of associated ants is also thought to contribute to the mortality of these trees.

Another pest that occurs in the young ponderosa pine stand adjacent to the seed orchard is the western pineshoot borer, Eucosma sonomana. Larvae of this insect mine the terminal shoots and cause height growth reductions.

Research studies have shown that shootborer infestations begin when the trees are approximately 5 years old and 1.5 m in height. Infestation rates increase over time. One study found that approximately 20% of the terminals were infested when the trees reached age 10, and 60% by age 20.

Although ponderosa pine planted in the seed orchard will not reach susceptibility to western pineshoot borer for a few years yet, a plan should be developed in advance to manage a potential future western pineshoot borer problem. This could be included in a seed orchard management plan for multiple pests.

Discussion

Many insects can be found in newly-established seed orchards and plantations. The mere presence of insects and/or minor insect-caused damage to seedlings sometimes leads to the perception that a pest problem exists. Under normal forestry operations, most minor damage or insect presence goes

unnoticed. However, because of the intensive management and high establishment and maintenance costs associated with seed orchard management, even the most minor anomaly associated with newly-planted and young seedlings in seed orchards and plantations may be viewed with concern.

Seedlings, whether growing naturally or established by artificial means, will incur varying degrees of insect-related damage throughout the juvenile stage, and sometimes beyond. Most of the damage from endemic populations will not result in significant damage unless compounded by other factors that stress young trees such as disease, drought, soil compaction, or other problems.

Usually, the presence of insects that are not damaging warrant only monitoring to detect any changes that appear to have the potential for causing adverse damage. Minor damage to seedlings can be largely ignored, and corrective action or intervention becomes necessary only when damage exceeds some threshold above which unacceptable or economic damage occurs (eg. threatens the growth, development, or survival of the seedlings).

Insect populations periodically flourish. The widespread appearance of the bark adelgid on ponderosa pine early this spring on the Kuhn Ridge Seed Orchard, is an example. Insect "outbreaks" such as this often disappear almost as rapidly as they appeared. High rates of adelgid mortality resulting from factors such as adverse weather, parasites, predators, and disease epizootics may be responsible for late season decline in insect numbers on the seed orchard. In these cases, the seed orchard manager's job is easy. Simple monitoring of the situation is the only response needed.

Aphids and adelgids have numerous natural enemies. It is very common to find immature and adult stages of species of the ladybird beetle (Coleoptera: Coccinellidae) feeding on aphids and adelgids. The larval stage of the syrphid or flower fly (Diptera: Syrphidae) are also voracious predators of aphids and adelgids and are often seen moving freely among their prey as they feed on sedentary individuals within the colony. The adult flies are marked with black and yellow and closely resemble wasps. Many other insects prey on or parasitize aphids and adelgids, and are partly responsible for maintaining aphid and adelgid pests of conifers and broadleafs at low levels; for this reason, chemical control is seldom advised.

The infestation by western pineshoot borer of ponderosa pine in the young stand adjacent to the plantation will eventually need to be suppressed to protect seed orchard trees. Chemicals constituting the sex pheromone used by female shoot borers to attract males for mating have been isolated and synthesized. Synthetic pheromones can be used to disrupt mating and prevent reproduction of western pineshoot borers in plantations. Reductions in terminal shoot infestation due to treatment have been reported to range from 66 to 84%. This technique currently is the only effective means of suppressing western pineshoot borer outbreaks. Plantations require annual followup monitoring, and may need to be retreated at 4-6 year intervals. The impact of shootborer infestation on cone production is not known.

Grasshoppers and the Mormon Cricket on Kuhn Ridge Seed Orchard are potentially the most damaging pests to Douglas-fir seedlings on the seed

orchard. Damage in 1989 has not been great, but with good overwintering survival of eggs, and favorable conditions next spring, populations could develop and result in severe damage. Dry, warm weather conditions would favor rapid insect development and early drying of preferred forage of grasses and forbs, resulting in the insects moving onto Douglas-fir seedlings.

The abundance of vegetation on the seed orchard probably saved the trees from severe damage by grasshoppers this year. Usually, when the grasses dry up, grasshoppers will switch to feeding on conifers from other vegetation which they prefer in the early nymphal stages. The first few nymphal stages will not feed on conifers, so adequate vegetation must be present to sustain them for several weeks. The amount of vegetation and the speed at which it dries during the summer appears to influence the probability of defoliation or damage.

Recommendations

Several options are available for controlling grasshoppers and crickets. The best approach, however, is to implement a variety of methods in a planned integrated pest management (IPM) approach to the grasshopper problem. Several other pests of the seed orchard should be included in a plan, as well.

This integrated approach involves what is known as a systems approach to the management of a pest and is based on the anticipated various consequences of methods proposed for managing pests including economic, ecological, and sociological.

The integrated multiple-pest management plan for the seed orchard should develop contingencies, where appropriate, where alternative courses of action are taken if earlier methods or mitigating measures fail.

Each step in the plan is tiered to the previous. For example, in managing the adelgid or aphid situation on the Kuhn Ridge Seed Orchard, the first step in the management plan should be to monitor insect activity and damage. A number of questions should be asked during the monitoring process to help to decide the proper course of action. Questions such as the following would help to develop a decision key to determine monitoring needs and pest management actions:

(1) Based on past experience or knowledge, is this insect one that is likely to cause unacceptable damage? (The seed orchard manager will have to decide what constitutes "unacceptable" damage for the particular orchard or plantation, and for the species concerned)

(2) Does the insect and damage warrant monitoring? (If the answer to question 1 is "no," further monitoring is not warranted)

(3) How often should monitoring be done? (Is once a month or once every two weeks often enough to detect adverse changes in population density or damage and still provide adequate time to take corrective action, if necessary?)

(4) What measurements should be taken during monitoring? (Insect density, quantitative or qualitative estimates of damage, spread of damage since last measurement, etc.)

(5) What are the damage thresholds for a particular insect feeding on a particular host? (Define what constitutes "unacceptable" damage so that a standard is available for reference and comparison)

(6) Has the pest reached the damage threshold, or how soon will the threshold be reached?

(7) Based on current pest levels and damage, what course of action should be taken? (Is it appropriate to take the corrective steps and mitigating measures in the order that have been defined in the action plan, or should more direct suppression measures described in later steps in the plan be used?)

Monitoring of the aphid or adelgid situation might lead the seed orchard manager to conclude that most of the time the insect population is kept in check by natural enemies; but in this case, the natural predators need to be augmented by releases of ladybird beetles or other predators or parasites (available through various sources).

Another phase of monitoring is conducted, and determines that augmentation of natural enemies had little effect. The followup phase then might be to use a safe, relatively non-toxic insecticidal treatment such as Safer's Insecticidal Soap.

If further monitoring found this treatment to be ineffective, and damage to seedlings was approaching levels that might seriously impact growth and survival, then the decision might be made to use a chemical insecticide such as Acephate, Lindane, Malathion, or others.

Each step of the plan is a little more drastic than the preceding, and depends upon failure or modicum results of the previous step, before implementation of the next step.

The pest management plan should also contain the necessary elements to implement pest management activities as required by regulation or law. In anticipation of the implementation of a short-term pest suppression activity, for example, the NEPA documentation should have already been done so that an action could be implemented without undo delays. Sometimes pest management activities must be undertaken swiftly on seed orchards when pests like grasshoppers threaten to destroy the seed orchard in one season. In this case, there would be inadequate time to conduct an environmental analysis and develop a NEPA document before the grasshoppers destroyed the orchard. The Prospect Ranger District's (Rogue River National Forest) draft Environmental Assessment for managing grasshoppers on District seed orchards is included for your information.

This NEPA document becomes part of the integrated multiple-pest management plan for the seed orchard. The plan should address both the long-term

management and short-term suppression of unacceptably high populations of grasshoppers and crickets on the seed orchard.

Grasshopper and cricket management on the Kuhn Ridge Seed Orchard should involve the use of a biological insecticide plus followup with chemical insecticide if needed. A biological insecticide application would serve as a preventative measure in the long-term strategy of grasshopper and cricket management on the seed orchard because the biological takes time to effect population reductions and would not result in immediate control of outbreaks. The chemical insecticide would be used when more rapid reduction of insect numbers is necessary to prevent severe damage.

Presently, the only biological control method available for grasshoppers and crickets is Nosema locustae, a naturally occurring protozoan parasite that infects many species of grasshoppers and crickets. It is most effective if introduced before the majority of grasshoppers and crickets have reached the third nymphal instar. Based on research evidence, Nosema can effect up to a 50-percent reduction in pest populations over several weeks and may provide some residual protection through intergenerational transmission of the disease, for one or more years following treatment.

Nosema is transmitted within existing populations by cannibalism brought on by overcrowding. Grasshopper and cricket densities in the range of approximately 15 to 22 insects per square yard apparently give optimal transmission rates of Nosema, although transmission of Nosema occurs at lower densities, but at declining transmission rates. Nosema is apparently no longer transmitted efficiently at densities of two insects per square yard or less.

The District's objective should be to introduce Nosema into the grasshopper population as soon as possible so that it can become established and begin providing long-term dampening of populations of grasshoppers and Mormon crickets on the seed orchard, to help mitigate future outbreaks.

Research data indicate that approximately 50 percent of Nosema-infected individuals survive for 4 to 6 weeks. Since Nosema is slow acting, best results are obtained when it is introduced in the early stages of an infestation or when an infestation is predicted. Laboratory evidence indicates that dry material is needed in the diet of early instar nymphs; therefore, Nosema formulated as a bran bait appears to be readily acceptable to early instars (third or fourth) present in an infestation being treated. A Nosema bran bait is available from Evans Biocontrol, Inc. as a product called NOLO BAIT. NOLOC is another wheat bran bait formulation of Nosema that is available from Sandoz, Inc. Both baits are registered by the U.S. Environmental Protection Agency for grasshopper control.

Since grasshopper occurrence in the area is quite widespread, a buffer of several hundred feet around the seed orchard perimeter should be treated with NOLO BAIT or NOLOC, as well, to provide added protection from grasshoppers that might migrate from the adjacent stand to the seed orchard. NOLO BAIT can be spread by hand or by manually- or automatically-operated seeding or fertilizing devices at the rate of 1.0 pound per acre. NOLOC can be applied at the rate of 1.5 pounds per acre using ground or aerial equipment. These baits have no restrictions for

applications around bodies of water and can be used up to the water's edge, in accordance with EPA regulations. Nosema is non-toxic and non-pathogenic to humans, livestock, birds, big game animals, insects other than the target pests, crops, or water resources.

The next phase of the integrated pest management approach is to utilize a chemical insecticide bait for immediate grasshopper and cricket population reduction. The carbaryl products SEVIN 4-OIL and SEVIN XLR PLUS have been approved by EPA for grasshopper control as a wheat bran-insecticide formulated bait. The SEVIN 4-OIL plus bran formulation is applied as a bran bait containing 5 percent active ingredient of carbaryl at a rate of up to 0.5 pounds of active ingredient per acre. As with the application of the biological insecticide in phase one of the pest management plan, a sufficient buffer of 200 feet or more will need to be treated around the seed orchard to provide protection of seedlings from migrating grasshoppers and crickets.

The use of biological and chemical insecticide bran baits in the first two phases of the pest management plan for grasshoppers minimizes the adverse effects on the environment and on non-target insects. These treatments, for example, will likely be the least disruptive to the natural predator/parasite complex of not only the grasshoppers and crickets, but also the adelgid and aphid pests on seedlings on the seed orchard and regeneration in the plantation surrounding the orchard.

The use of carbaryl baits is expected to have fewer environmental impacts than Ultra Low Volume (ULV) sprays. Under normal operating procedures, carbaryl bait should have no impact on soils. In addition, the nonphytotoxicity of carbaryl and the minimal contact of bran bait with leaf surfaces should prevent adverse effects to vegetation.

Unlike Nosema bait, carbaryl bait applications should not be made within 200 feet of bodies of water supporting higher aquatic life. Also, carbaryl bait would not reach water from drift, so there should be no impacts on water quality or aquatic organisms under normal circumstances.

Carbaryl is slightly toxic to birds and moderately toxic to mammals. The only nontarget organisms at risk from carbaryl bait applications would be granivorous species that ingested bait flakes. In some cases, individual birds or mammals could receive doses adequate to cause toxic effects or death. Temporary cholinesterase (ChE) depression would occur when any animal ingested carbaryl bait. But because the insecticide carbaryl belongs to the class of pesticides known as carbamates, it is broken down in the body rather rapidly, and its effect on cholinesterase is quite brief. The reduction in the numbers of grasshoppers under any method could also affect wildlife species that feed primarily or preferentially on grasshoppers, but those effects could be offset as alternative food sources are utilized. There would be no impact on foraging honey bees.

These two treatment strategies may be adequate for management of current grasshopper and cricket infestations on the Kuhn Ridge Seed Orchard. Failure or unsatisfactory performance of either or both of these strategies would lead to the final, and perhaps least environmentally or sociologically acceptable treatment strategy--aerial or ground application of chemical

insecticides. It is likely that this phase of the plan would be reserved only for emergency situations where extremely high populations of grasshoppers could cause rapid devastation of the seed orchard, and there is not enough time for the earlier strategies to be implemented and become effective.

A number of chemical insecticides are registered for control of grasshoppers. Of those registered, carbaryl, acephate, and malathion are the most commonly used for grasshopper and Mormon cricket control in the west.

In rangeland and cropland grasshopper control operations, chemical insecticides aerially broadcast applied in ULV applications have shown to be most effective in suppressing outbreaks. The insecticide products and the application rates used include carbaryl (0.5 pounds active ingredient per acre); acephate (0.094 pounds active ingredient per acre); and malathion (0.58 pounds active ingredient per acre).

The insecticide of choice is dependent on many biological, environmental, social, economic, and political factors, of course, and we shall not attempt to enumerate them. From a purely biological point of view, however, generally carbaryl spray works best early in the season, against younger stages; whereas, older nymphs and adults are usually treated with acephate or malathion sprays to achieve best results against those stages.

A more detailed discussion of the use, benefits, risks, and exposure analysis of each of these chemical insecticides for grasshopper suppression is contained in the attached Prospect RD Environmental Assessment draft and in other documents. Please contact me for additional information and references.

The potential use of chemical insecticides in an integrated pest management approach to grasshopper and other insect management programs for the Kuhn Ridge Seed Orchard should not be ignored. It is an integral part of the management strategy of insect pests on any seed orchard, and there will be times when the District may have no other choice--however unpopular it may be--but to use chemical insecticides to protect seedlings or seed crops, or suffer the complete destruction of seedlings or seed orchard crops, to insect pests.

Chemical usage in tree improvement programs is a reality, and will undoubtedly increase in future years as trees grow into maturity, begin producing cone crops, and become threatened by a myriad of insect pests that would otherwise reduce and destroy seed crops, and disrupt the District's supply of genetically improved trees grown from seeds produced in seed orchards.

As the Forest's Tree Improvement program is just getting under way, the time is appropriate to begin developing integrated multiple-pest management plans to effectively address the pest prevention, detection, evaluation, and suppression needs of seed orchards and evaluation plantations on all the districts, if not done already. The plan should cover the multitude of major pests--as best we can identify them--that are likely to occur on

orchards and plantations including insects, diseases, animals, and unwanted vegetation.

Pest specialists at this Zone office and at Forest Pest Management (RO) are available to assist with these and other pest problems. In addition, colleagues with APHIS and ODA at Hermiston are available to assist with identification of grasshopper species, and determining the need for control and appropriate timing of treatment applications. Contact me for additional information.

Donald W. Scott

DONALD W.SCOTT
Zone Entomologist

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